<u>Standard for Vegetative Filter Strip</u>

<u>Definition</u>

An area of perennial grasses through which stormwater runoff flows before leaving a site or entering a storm sewer system. Pollutants suspended in the runoff or attached to suspended soil particles are removed by filtration, absorption and gravity sedimentation.

<u>Purpose</u>

A vegetative filter strip or buffer area is designed to remove pollutants from overland runoff. This practice is typically used in conjunction with other water quality practices to achieve overall water quality improvement objectives. Under ideal conditions where runoff flows uniformly across the filter area without concentrating or short-circuiting, filter strips can be effective in reducing sediments and other associated pollutants such as nitrogen and phosphorous.

<u>Condition Where Practice Applies</u>

The vegetative filter strip shall only be used in unconcentrated overland flow situations, where runoff reaches the strip in sheet flow. Filter strips are **not** intended to treat concentrated discharges from storm sewer outlets. Filter strips may be successfully used above constructed water courses (such as waterways and diversions) and natural water bodies (such as streams, ponds and lakes) to treat runoff from the immediate surrounding areas. Filter strips may also be used to treat runoff from industrial and commercial sites such as parking lots and strip malls, where filters are installed between impervious areas and receive sheet flows.

<u>Design Criteria</u>

1.   Minimum vegetated filter strip length is 20.0 feet
2.   Overland flow Kinematic "n" vales for cover types in filter strips:

Table 1

Surface Description of Filter Strip	"n" value[1]
Sparse vegetation	0.13
Lawns	0.25
Bluegrass sod	0.35
Open field	0.40
Woods - Light underbrush	0.50
- Heavy underbrush	0.60

1. "n" value used in Figure 2.

3.   Maximum slope of Filter Strip by soil type and cover.

Table 2

Soil Type	Maximum Allowable Vegetative Filter Slope, ft/ft[1] by cover type		
	1. Forest (dense vegetative ground cover) **2. Meadow**	**1. Forest** (sparse vegetative ground cover) **2. Poor Turf** (sparse stands)	**Healthy Turf** (dense stands)
Sands	0.05	0.03	0.07
Sandy Loam	0.07	0.04	0.08
Silt Loam	0.08	0.05	0.08
Sandy Clay loam	0.08	0.06	0.08
Clay loam	0.08	0.07	0.08
Graded loam to gravel	0.08	0.07	0.08

1. Lands with slopes greater than those shown should not be utilized for a filter strip regardless of cover type
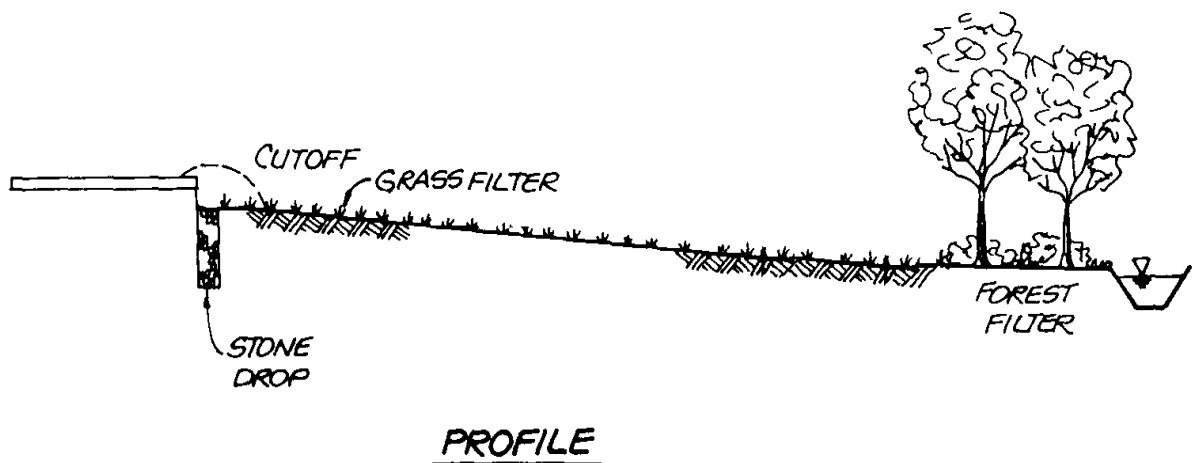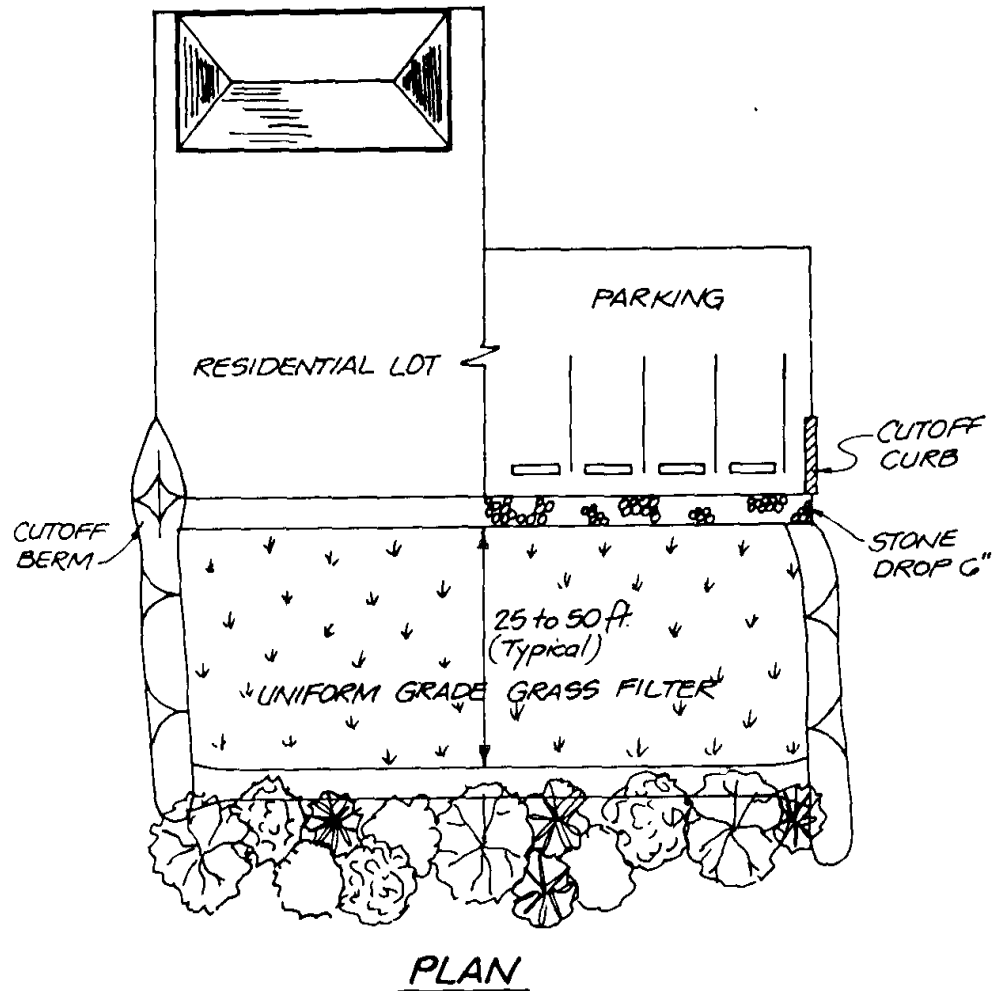
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Figure 1. Typical vegetative filter strip

6. Theoretical trap efficiency criteria is 80% for <u>coarse</u> silt soils
   (Note: in most situations, removal of total suspended solids will not exceed 60%, even under optimum conditions and maintenance.)
   When the contributing drainage area consists of soils other than coarse silt, the filter strip length determined by Figure 2 should be multiplied by the appropriate length correction factors shown below.

Table 3

Soil Type (from drainage area)	Length Correction Factors
Fine Silt	1.8
Medium Silt	1.3
Sands	Use length determined by Figure 2 graph

5. Drainage Area Limit

   A contributing drainage area of any size may be directed to flow through a filter strip provided the flow from the contributing drainage area enters the filter strip as sheet flow. Maximum sheet flow travel lengths for various combinations of slope and "n" values are shown in Table 4. The flow length is measured perpendicular to the leading edge of the filter strip. The interface between the contributing drainage area and the filter strip must be as horizontal as possible so that runoff will be evenly distributed along the leading edge of the filter. Paved surfaces may eliminate curbing or employ a recessed curb to achieve a horizontal weir for distribution of the runoff.

7. Vegetation

   <u>Filter strip vegetation must be fully established before incoming stormwater flow is allowed</u>. At least one full growing season should have elapsed prior to strip functioning as part of the stormwater management system. Species for planting shall be taken from the Appendix: Landscaping BMPs, or the USDA NRCS Field Office Technical Guide Standard 342. Species must be appropriate for the region, soil, and shade condition. Mulching of the seeded strip is required.

<u>Considerations</u>

Filter strips have been shown to be effective in removing sediment and pollutant loads in urban stormwater runoff. In order to adequately address water quality considerations, filter strips must be designed to provide at least 60% trap efficiency. Also, all runoff entering the filter strip must be overland sheet flow. Where catch basins and storm sewers are used to collect and transport runoff, velocities and point discharges preclude the use of filter strips as effective water quality controls.

Pollutant removal efficiencies for filter strips have been established primarily through modeling studies with limited field tests confirming these results. All suggest that filter strips are moderately effective in removing particulate pollutants including sediment, organic material and trace metals. The rate of removal appears to be a function of length, slope and soil permeability of the strip, the size of the contributing runoff area and the runoff velocity.

Soluble pollutants are removed indirectly. The runoff must first infiltrate into the soil with nutrients eventually being absorbed by the vegetation. Therefore, the amount of removal varies with soil permeability and plant uptake.

Almost any stand of vegetative cover will remove some sediment from water flowing through it. The filter strips can occur naturally or be man-made. The type of vegetation used can be very broad. Best performance is associated with dense stands of vegetation, whether it consists of turf forming grasses or dense forest floor vegetation.

The most common, naturally occurring filter strips are those vegetative stands associated with floodplains or found adjacent to natural swales and watercourses. In some cases, preservation of these areas is all that is required for them to continue to function as filter strips. As these filter strips are expected to perform for several months or more, a top dressing of fertilizer may be necessary to improve the stand. In areas where natural vegetation is of poor quality or nonexistent, it is possible to establish a man-made vegetative filter.

When filter strips are used in treating sediment-laden runoff, a number of factors should be considered. Most importantly, an adequate filter area and length of flow must be provided to achieve the desired treatment. Slopes of less than five percent are more effective; steeper slopes require a greater area and length of flow to achieve the same effectiveness. Good drainage is necessary to ensure satisfactory performance. The designer should also be aware of potential ponding factors during the planning stage. Dry period between flows should be accounted for to reestablish aerobic soil.

Operations and Maintenance

Maintenance should occur on a regular basis, consistent with favorable plant growth, soil, and climate conditions. Typical maintenance tasks are: mowing at least twice per year, liming, pest control, reseeding, erosion repair, and sediment removal from the uphill edge of the strip. If at any time, the stand of vegetation is over 50% damaged, the strip shall be reestablished

according to original specifications.

Table 4

Maximum lengths[1] of possible sheet flow (in feet) from various combinations of slope and "n" values of contributing drainage areas.

Slope ft/ft	Kinematic "n" for cover types in <u>contributing</u> drainage areas			
	0.02 (Bare Soil Condition)	0.05 (Pavement flow 0.25" to several inches)	0.1 (Pavement < 0.25in)	0.2 (Very short grass)
0.005	354	141	71	35
0.01	500	200	100	50
0.02	707	283	141	71
0.04	1000	400	200	100

1. Length limit, $L = 100S^{0.5}/n$ <u>Assessment of Kinematic Wave Time of Concentration</u>, R. H. McCuen, Jill M. Spiess.
Journal of Hydraulic Engineering, Vol. 121, No. 3, March 1995.

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Figure 2. Vegetative Filter Strip Length Determination for Theoretical 80% Trap Efficiency in Coarse Soils

$$L = 15.7 + 0.0004S^{1.11}[\log_{10}(1+n)]^{-2.26}10^{0.0523TR}$$